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APPLICATION FOR LETTERS PATENT

for

METHODS OF TANK CONSTRUCTION

Inventors:

Keith B. Fisher  
Mark R. Miskin

Attorneys:  
Andrew F. Nilles  
Registration No. 47,825  
Bretton L. Crockett  
Registration No. 44,632  
TRASKBRITT, PC  
P.O. Box 2550  
Salt Lake City, Utah 84110  
(801) 532-1922

# TITLE OF THE INVENTION

## METHODS OF TANK CONSTRUCTION

### TECHNICAL FIELD

[0001] The present invention relates generally to the field of tanks for holding fluids, and more particularly to the field of tank manufacturing.

### BACKGROUND

[0002] Fluid tanks typically have high strength requirements because of the weight of the fluid or the pressured gas to liquid stored in the tanks. Thus, some tanks are constructed from metal. These metal tanks typically have various pieces that are welded together to form the tank. This welding may be effectuated by placing a person on the inside of the tank during the tank construction and having the person inside the tank weld the pieces together such as disclosed in U.S. Patent 6,161,179 to Madison, the contents of which is incorporated herein by this reference.

[0003] Tank interiors qualify as confined spaces and are subject to regulations of the Occupational Safety and Health Administration (OSHA). As known in the art, a person working in a confined space is more susceptible to injury, illness and even death. For instance, the confined space may subject the worker to dangers from explosion, poisoning and asphyxiation. Tank manufacturers, thus, must take appropriate steps and safety precautions to guard against these hazards pursuant to the OSHA regulations, including providing respirators and other safety equipment that is not required for external welding. Implementation of these appropriate steps and safety precautions by the tank manufacturer add both time and money costs to tank construction.

[0004] Further, many tanks are constructed of materials that may corrode or rust during use. Thus, these tanks may be lined with a corrosion resistant liner, such as that disclosed in U.S. Patent 6,431,387 to Piehler, the entirety of which is incorporated by this reference. Some liners may be applied by spraying a coating of liner material on the inside of the tank. The addition of the liner adds expense and time to the manufacturing process and, thus, increases the cost of the tank to the ultimate consumer. Since the application of a liner adds more work in a confined space, the incorporation of the liner may further subject the tank manufacturer additional expense and safety issues as well as governmental regulations.

[0005] Thus, a more efficient process of manufacturing a tank and the tank resulting therefrom would constitute an improvement in the art.

#### BRIEF SUMMARY OF THE INVENTION

[0006] In one aspect of the present invention, a method of fabricating a tank substructure is disclosed. The method includes forming a framework of a tank, wherein the framework comprises a first end plate, a second end plate and an interior wall. A portion of a sheet is placed in contact with the framework of the tank such that the sheet circumscribes a portion of a periphery of the first end plate or the second end plate, and wherein the sheet circumscribes a portion of a periphery of the interior wall. The sheet is sized such that a first end of the sheet defines a portion of a first surface of the tank and such that a second end of the sheet defines another portion of the first surface of the tank. A portion of the sheet disposed between the first end and the second end defines a portion of a second, opposing surface of the tank. A seam is formed between the sheet and the framework on an exterior of the tank.

[0007] In another aspect of the present invention, a tank is produced by a process. The process comprises forming a framework of a tank, wherein the framework includes a first end plate, a second end plate and an interior wall. A portion of a sheet is placed in contact with the framework of the tank, such that the sheet circumscribes a portion of a periphery of the first end plate or the second end plate. The sheet also circumscribes a portion of a periphery of the interior wall. The sheet is sized such that a first end of the sheet defines a portion of a first surface of the tank and a second end of the sheet defines another portion of the first surface of the tank. A portion of the sheet disposed between the first end and the second end defines a portion of a second, opposing surface of the tank. The sheet is welded to the framework such that a bead of weld is formed on an exterior of the tank.

[0008] In an additional aspect of the present invention, a tank having a substantially planar first end plate and a substantially planar second end plate is described. The tank further includes an interior wall, wherein a portion of the periphery of the interior wall comprises a flange. A sheet is attached to a periphery of the first end plate or the second end plate. A portion of the sheet is also attached to a portion of the flange by a seam. A first end of the sheet and a second end of the sheet

each define a portion of the first surface of the tank. A portion of the sheet located between the first end and the second end comprises a portion of an opposing, second surface of the tank.

[0009] In yet a further aspect, another method of forming a tank substructure is described. The method includes forming a framework of a tank, wherein the framework comprises a first end plate, a second end plate and at least one interior wall. A sheet is sized such that a first end of the sheet defines a portion of a first surface of the tank and a second end of the sheet defines another portion of the first surface of the tank when the sheet is placed in contact with the framework of the tank. The sheet circumscribes a portion of a periphery of the first end plate, a portion of a periphery of the second end plate, and a portion of a periphery of the at least one interior wall. A first opening, a second opening, and a third opening are formed in the sheet. The first opening is substantially aligned with the periphery of the first end plate, the second opening is substantially aligned with the periphery of the second end plate, and the third opening is substantially aligned with the periphery of the at least one interior wall. The sheet is placed in contact with the framework of the tank, such that the sheet circumscribes a portion of the periphery of the first end plate, the second end plate, and the at least one interior wall, such that a first end of the sheet defines a portion of a first surface of the tank and a second end of the sheet defines another portion of the first surface of the tank. A portion of the sheet disposed between the first end and the second end defines a portion of a second, opposing surface of the tank. An inside edge of the first opening is welded to the periphery of the first end plate, an inside edge of the second opening is welded to the periphery of the second end plate, and an inside edge of the third opening is welded to the periphery of the at least one interior wall, wherein the welding is performed from an exterior of the tank substructure.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0010] It will be appreciated by those of ordinary skill in the art that the elements depicted in the various drawings are not drawn to scale, but are for exemplary purposes only. The nature of the present invention, as well as other embodiments of the present invention, may be more clearly understood by reference to the following detailed description of the invention, to the appended claims and to the several drawings, wherein:

[0011] FIG. 1 is a perspective view of a partially constructed tank of one exemplary embodiment of the present invention.

[0012] FIG. 2 is a partial top view of the tank of FIG. 1.

[0013] FIG. 3 is an end view of the tank of FIG. 1.

[0014] FIG. 4 is an exploded view of a seam of the tank of FIG. 1.

[0015] FIG. 5 is an exploded view of another exemplary embodiment of a seam of the tank of FIG. 1.

[0016] FIGS. 6A-6C illustrate a process for forming the seam of FIG. 4.

[0017] FIG. 7 is an exploded view of another exemplary embodiment of the seam of the tank of FIG. 1.

[0018] FIG. 8 illustrates one method of positioning the sheets of the seam of FIG. 7.

[0019] FIG. 9 depicts an exploded view of an additional exemplary embodiment of the seam of the tank of FIG. 1.

[0020] FIGS. 10A and 10B illustrate another method of positioning the sheets on the baffles of the tank.

[0021] FIG. 11 is another perspective view of the partially constructed tank of FIG. 1 in the fabrication process.

[0022] FIG. 12 illustrates a tank constructed with the methods of the present invention with the addition of manhole covers.

## DETAILED DESCRIPTION

[0023] The present invention relates generally to processes for fabricating tanks. The tanks may be used to store materials including, but not limited to, liquids, fluids, slurries, gases, granular materials, or combinations of any thereof, and the tank may be configured as a stationary tank or a mobile tank. More specifically, some embodiments of the present invention relate to a process for fabricating a corrosion resistant tank, wherein the fabrication process is more efficient and economical than known fabrication processes. It will be apparent to those of ordinary skill in the art that the embodiments described herein, while exemplary, are not intended to so limit the invention or scope of the appended claims. Those of ordinary skill will understand that various

combinations or modifications of the embodiments presented herein may be made without departing from the scope of the present invention.

[0024] Referring now to FIG. 1, there is shown a perspective view of a partially constructed tank fabricated with a method of the present invention generally at 10. Phantom lines are used to depict the finished tank 10. In the exemplary embodiment, the tank 10 includes four sections 12a-12d indicated with brackets. It will be apparent to those of ordinary skill in the art that the tank 10 may comprise any number of sections 12. The tank 10 has a first end 14 and a second end 16, wherein the first end 14 and second end 16 comprise substantially planar plates that define a shape of the tank 10. Although the exemplary embodiment depicts a tank 10 having a substantially rectangular shape with rounded corners, it will be apparent to those of ordinary skill in the art that tank 10 may be designed to have virtually any shape. Tanks that are generally polygonal in shape may be especially suited for the methods of the present invention.

[0025] The sections 12a-12d may be separated by transverse members, such as transverse baffles 18a-18c. The transverse baffles 18a-18c make up interior walls of the tank 10 and function partially to provide support to the tank 10. The transverse baffles 18a-18c are connected to longitudinal members, such as longitudinal baffles 17a-17d, which also make up interior walls of the tank 10 and also provide support to the tank 10. As known in the art, the baffles are configured to include at least one opening (not shown) that allow the sections 12 of the tank 10 to be in communication, while preventing excessive surges of fluid in the tank 10 during transport.

[0026] The first end 14, transverse baffles 18a-18c, longitudinal baffles 17a-17d, and second end 16 make up a "skeleton" or framework of the tank 10. The framework supports a skin that makes up an exterior of the tank 10. For instance, sections 12a and 12b are partially enclosed by sheets 20a and 20b, respectively. Each sheet 20a and 20b comprises a single sheet of metal having a first end 22 and a second end 24, wherein the sheet 20a is "wrapped" around an edge of the first end 14 of the tank 10 and transverse baffle 18a. Sheet 20b is wrapped around an edge of transverse baffle 18a and transverse baffle 18b. In one exemplary embodiment, the sheets 20a and 20b are bent to conform to the shape of the first end 14 and transverse baffles 18a and 18b. The sheets 20 may be heated during the wrapping process to accommodate the shape of the baffles 18, may be shaped by: rolling with a mechanical roller prior to wrapping; forming multiple small bends in the sheets 20 with a press brake; or be otherwise formed into a desired shape as known to those of

ordinary skill in the art. The sheets 20a and 20b form a bottom surface 13, a first sidewall 11, a second sidewall 19, and portion of a top surface 15 of the tank 10. An opening, indicated by bracket 21, located between and defined by the first end 22 and the second 24 of the sheets 20, has a dimension of between about four feet and eight feet. As further indicated, sections 12a-12d are configured with wheel wells 23 such that the tank 10 may be placed over wheels of a flat bed truck or a trailer. In another exemplary embodiment, the wheel wells 23 may be omitted from the tank 10.

[0027] Referring now to FIG. 2, there is illustrated a partial top view of the tank 10 of FIG. 1. As depicted in FIG. 2, the four sections 12a-12d may each be fitted with a skin 20a-20d, respectively. A periphery of each of the transverse baffles 18a-18c includes a flange 26a-26c, respectively, and as illustrated in the top view, an external weld bead 28a-28c is used to attach each of the sheets 20a-20d to the transverse baffles 18a-18c, respectively. The welding process may be performed in any suitable manner known to those of ordinary skill in the art. FIG. 3 depicts a cross-section of the tank 10 of FIG. 1 along line 30. The transverse baffle 18a is circumscribed by the sheet 20a that is wrapped around the periphery of the transverse baffle 18a. Some possible embodiments of openings 25 that allow the sections 12 of the tank 10 to be in communication with one another are depicted in phantom.

[0028] Referring now to FIG. 4, there is shown an exploded view of a seam between the transverse baffle 18a, and sheets 20a and 20b of FIG. 2. A flange 32, such as a "T" flange, is attached to the transverse baffle 18a with two weld beads 34a and 34b, which in the exemplary embodiment may be stitch welds. The flange 32 is used as a backing strip for welding the sheets 20a and 20b to the flange 32, thus forming the weld bead 28a. The welding on the sheets 20 may be performed from an exterior of the tank 10. It will be apparent to those of ordinary skill in the art that each of the seams 28 attaching the sheets 20 to the transverse baffles 18 of the tank 10 may be constructed in this manner. In another exemplary embodiment, the flange 32 may be formed as part of the transverse baffle 18a such that the stitch welds 34a and 34b may be omitted. It will be appreciated that the flange 32 may be formed in any suitable manner.

[0029] FIG. 5 illustrates another exemplary embodiment of the seam between the sheets 20a and 20b and the transverse baffle 18a. The transverse baffle 18a has an "L" flange 32' formed

as part of the transverse baffle 18a. The sheets 20a and 20b are attached to the "L" flange 32' by welding to form the weld 28a. The welding was performed from an exterior of the tank 10.

[0030] Referring now to FIGS. 6A through 6C, there is shown one exemplary embodiment of a process for forming the exterior weld bead 28a of FIG. 4. A first exterior weld 29a is formed to attach sheet 20a to the flange 32 as depicted in FIG. 6A. Exterior weld 29a may be formed as sheet 20a is wrapped around the framework and baffle 18a. A second exterior weld 29b may then be formed to attach sheet 20b to the flange 32 as depicted in FIG. 6B, again, this may occur as sheet 20b is wrapped around the framework and baffle 18a. The exterior weld 28a may then be formed by filling in the gap, indicated by arrow 31, with weld material to complete the attachment of the two sheets 20a and 20b to the flange 32 as depicted in FIG. 6C. In another embodiment, the two sheets 20a and 20b are attached to the flange 32 in a manner such that the two sheets 20a and 20b are also attached to each other such as, for example, by welding. The weld used to attach the two sheet 20a and 20b together may run substantially an entire length of the seam formed between the two sheets 20a and 20b. The surface of the resulting weld 28a may then be ground down to the level of the sheets 20a and 20b to result in a smooth joint.

[0031] FIG. 7 illustrates an exploded view of another embodiment of a seam between the transverse baffle 18a and sheets 20a and 20b of FIG. 2. As illustrated, the flange 32 is attached to the transverse baffle 18a with stitch welds 29a and 29b, and the sheets 20a and 20b are positioned against an interior edge of the flange 32 and two welds 33a and 33b are formed from the exterior of the tank 10 to attach the sheets 20a and 20b to the flange 32. A distance between the edges of the transverse baffle 18a and the sheets 20a and 20b may be varied in order to make the assembly of the tank 10 more efficient. FIG. 8 illustrates one method of positioning the sheets 20a and 20b of FIG. 7 wherein a pry bar 41 is placed against a stop or lug 43, and used to push the sheets 20a and 20b into position against the flange 32.

[0032] Referring now to FIG. 9, there is illustrated an exploded view of yet another embodiment of the seam between the transverse baffle 18a and sheets 20a and 20b of FIG. 2. In the illustrated embodiment, the sheets 20a and 20b are attached to the transverse baffle 18a with welds 33a and 33b formed from an exterior of the tank 10.

[0033] FIG. 10A is a perspective view of one method of wrapping a sheet 20 around baffles 18a-18c of the tank 10. As illustrated, the sheet 20 is one piece and includes a plurality of



slots 9a-9c formed in the sheet 20. Slots 9a are substantially linear and are aligned with the baffle 18a, slots 9b are substantially linear and are aligned with the baffle 18b, and slots 9c are substantially linear and are aligned with the baffle 18c. FIG. 10A also illustrates longitudinal baffles 17a-17c, but it will be apparent that the longitudinal baffles 17a-17c may be omitted from the tank in other embodiments. It will be apparent to those of ordinary skill in the art that a row of slots 9 will be formed in the sheet 20 for each baffle 18, a first end 14 (*See*, FIG. 1), and a second end 16 (*See*, FIG. 1) of the tank such that the sheet may be attached to each baffle 18, the first end 14, and the second end 16. The sheet 20 is wrapped around and attached to the baffles 18a-18c, such as by forming a bead of weld between inside edges of the slots 9a-9c and the flanges of the baffles 18a-18c, wherein the bead of weld is formed from the exterior of the tank 10. The bead of weld may be formed as previously discussed herein with regard to FIGS. 2-6C. In the exemplary embodiment, any number of sheets 20 including, for example, one sheet 20 or a plurality of sections making up the sheet 20, may be used to form the skin of the tank.

[0034] By wrapping a single sheet 20 around the baffles 18a-18c, the alignment of the sheet 20 to the flange of the baffles 18a-18c and a seam formed between the inside edges of the slots 9a-9c will be substantially uniform and square. Transverse member 7, such as a back-up strap, may also be attached to the baffles 18a-18c. The transverse member 7 may be used to additional support of the sheet 20 or if the sheet 20 comprises multiple sections, may be used to overlap sheets 20 to form the skin of the tank. The transverse member 7 may comprise corrosion resistant metal and be attached to the baffles 18a-18c by welding. Openings such as, for example, slots 9 may also be formed in the sheet 20 that substantially align to the transverse member 7 such that the sheet 20 may also be welded to the transverse member 7 from the exterior. In addition to wrapping the sheet 20 around the baffles 18a-18c, in another exemplary embodiment, the sheet 20 may be pre-shaped, such as by bending or rolling, as illustrated in FIG. 10B, wherein the pre-bent sheet 20 is attached to the baffles as illustrated in FIG. 10A. It will be apparent that that the sheet 20 of FIG. 10B may comprise two halves or any number of sections of the sheet 20, wherein each halve or section will be attached together to covers the tank. In this embodiment, the two halves of the sheet 20 or the various sections of the sheet 20 may be partially attached together. The partially attached halves or sections may be “wrapped” around the framework of the tank and the process of attaching the sheet 20 to the framework may be completed.

[0035] Referring again to FIG. 1, in yet other embodiments, slots (not illustrated) may be formed in the edges of individual sheets 20a-20b, wherein the sheets 20a-20b may be attached to the first end 14, the second end 16, and the baffles 18a by welding an inside edge of the slots to the flanges of the baffles 18a-18b or a periphery of the first end 14 or the second end 16.

[0036] FIG. 11 is another perspective view of the partially constructed tank 10 of FIG. 1 with the addition of top plates 36a and 36b. Portions of the completed tank 10 are shown in phantom. The top plates 36a and 36b extend from the first end 14 of the tank 10 to the second end 16 of the tank 10 and may attach to the tops of the baffles 18 for additional support. Top panels 38a and 38b may be positioned on the upper surface 15 of the tank 10. An extending edge 40 of the top panels 38a is received by slots 42 of the longitudinal baffles 17a-17d. The placement of the top plates 36a and 36b, and top panels 38a and 38b form at least one opening 44 which provides access to an interior of the tank 10. Multiple openings 44 may be desired to provide access to the compartment formed between each latitudinal baffle 18. A manhole or other sealable access port may be formed at each opening 44.

[0037] In some exemplary embodiments, the various components of the tank 10 may comprise a high strength, corrosion-resistant steel, such as Domex 100W or Cor-Ten that are welded together. The thickness of such components may be about approximately 0.25 inches. By using such corrosion resistant steel, a liner can be omitted from the finished tank 10, obviating the need for confined space spraying of a plastic lining material. In other exemplary embodiments, some or all of the components of the tank 10 may comprise other known corrosion resistant metals including, but not limited to, aluminum, galvanized steel, stainless steel, titanium, nickel and cobalt based alloys, or alloys of any thereof.

[0038] Referring again to FIG. 11, although not illustrated for sections 12c and 12d, the completed tank 10 will have sheets 20 covering all of the sections 12a-12d. In one embodiment, a completed tank 10 may have a capacity of about 5,000 gallons, with a height (H) of about 52 inches, a width (W) of about 117.5 inches, and a length (L) of about 217 inches. Of course, it will be apparent by those of ordinary skill in the art that the tank 10 may be configured to have a larger or smaller capacity with corresponding larger or smaller dimensions. The completed tank 10 may be configured to be placed on a trailer chassis (not shown) that is pulled by a tractor or be configured to be placed on a bed of a truck (not shown). In other exemplary embodiments, the tank 10 may be

configured for any other use, such as for stationary storage. The tank 10 may be formed with an inset portion, indicated by arrow I, to facilitate the tank mounting and any additional structures needed for mounting may be included. Embodiments where the inset I is not needed, or is formed in a different location are within the scope of the present invention.

**[0039]** A substantially completed tank 10 is illustrated in the perspective view of FIG. 12. As depicted, the tank 10 includes four completed sections 12a-12d including sheets 20a-20d, respectively. The tank 10 includes man-hole plates 50a and 50b, which are substantially rectangular covers. The man-hole plates 50a and 50b are bolted to the top plates 36a and 36b, and to the top panels 38a-38c by welding studs 56 to the top plates 36 and top panels 38 and placing bolt-holes, or openings, of the man-hole plates 50a and 50b over the studs 46, and bolting the man-hole plates 50a and 50b onto the top plates 36 and top panels 38. One of the man-hole plates, 50b in the exemplary embodiment, is configured with an opening 54 therein, which is screened and functions as a vent and for filling the tank 10.

**[0040]** It will be appreciated by those of ordinary skill in the art that the embodiments described herein are not intended to limit the scope of the present invention. Various combinations and modifications of the embodiments described herein may be made without departing from the scope of the present invention and all modifications are meant to be included within the scope of the present invention. Thus, while certain exemplary embodiments and details have been described for purposes of describing the invention, it will be apparent by those of ordinary skill in art that various changes in the invention described herein may be made without departing from the scope of the present invention, which is defined in the appended claims.